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An analysis of sudden, large falls in temperature at Lyneham during periods of weak advection

By B. J. Booth

(Meteorological Office, Royal Air Force Lyneham)

Summary

Following an unexpected and large fall in temperature at Lyneham in light winds during the early hours of 30 January 1981, the records were examined to find similar previous events. This paper describes the results of that search and identifies the situations when the phenomenon is most likely to occur.

Introduction

Sudden, large falls ($\geqslant 3.5\,^{\circ}C$) in temperature are phenomena usually associated with large-scale air-mass change but, while this is generally true, a study of the records for Lyneham in Wiltshire suggests that other causes must also be considered because, of 15 such events since 1954, 5 occurred during, or immediately following, periods of weak advection.

Lyneham (maximum elevation 156 m above mean sea level (m.s.l.)) is situated on a dome-shaped limestone outcrop with steep descents in the north-western semicircle from the airfield perimeter to the floor of the Avon valley 90 m below. The north-facing slope, Lyneham Banks, is especially severe with a mean gradient of about 1:8 along its 3.5 km length (Fig. 1). The slope in the eastern quadrant is much less

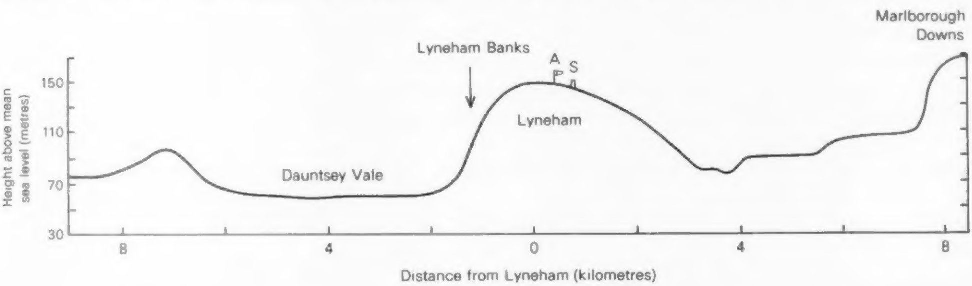


Figure 1. Topographical cross-section through Lyneham along 330°–150°. A and S are present sites of anemometer and instrument enclosure respectively.

marked and continues for some 6–8 km before reaching the scarp of the Marlborough Downs. The low ground immediately north of Lyneham, Dauntsey Vale, is a natural depression, bounded in the north-east by a watershed extending north-west from Wootton Bassett, and in the north-west by the southern slopes of the Cotswolds (Fig. 2).

The major waterway in the locality is the River Avon, but there are several minor streams, and mist or fog is often observed near these long before visibility decreases on the airfield.

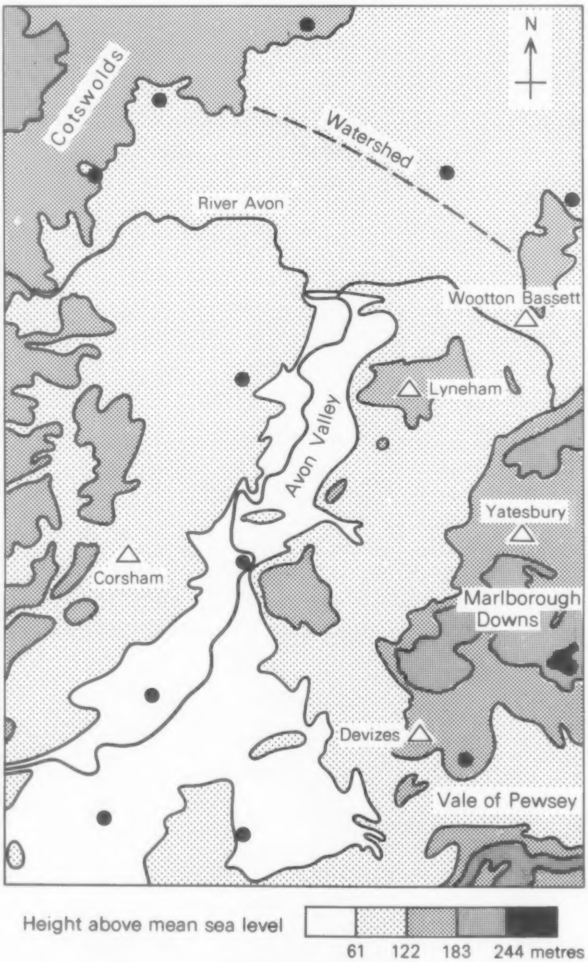


Figure 2. Locations of places referred to in the text (△) and observation sites (●).

Since 1961 the observing office has been located in the Air Traffic Control (ATC) building and is surrounded by open grassland, but previously observations were made from the site of the old ATC building near the airfield complex some 500 m to the north-east. Both sites are within 1000 m of the north and south-west facing slopes bounding the airfield (Fig. 3).

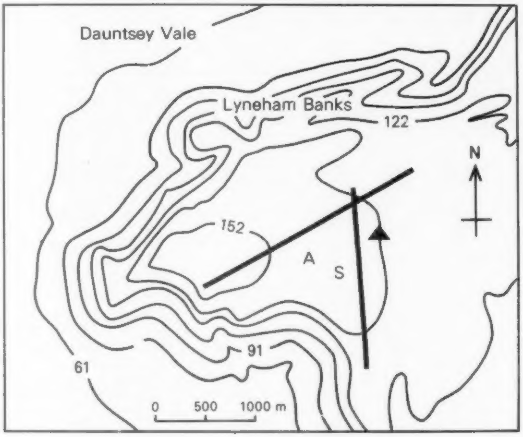


Figure 3. Topography in the immediate vicinity of Lyneham. Heights are in metres above mean sea level and contours are at 15-metre intervals. A and S are present locations of anemometer and instrument enclosure, and ▲ is the site of the instrument enclosure before 1961.

Before 1959 the anemometer was positioned 15 m above ground level on the roof of the old ATC building, where it was sheltered by hangars from winds in the eastern quadrant. During May 1959 it was repositioned on a lattice tower 13 m above ground level, 300 m north-west of the present observing office. An anemograph was not installed until 1976, so until this date only hourly wind values read directly from anemometer dials are on record, and it must be recognized that in very light winds these do not reflect all variations of direction.

In the following descriptions of the five events the absolute values of temperature changes must necessarily be approximate owing to the limitations of the thermograph. The temperature traces in Fig. 4 have been adjusted with respect to time and, where appropriate, transferred from a Fahrenheit to a Celsius scale. (Any errors created by this action are considered insignificant in the context of this paper.) All references to wind and temperature relate to surface conditions at Lyneham unless otherwise specified.

No significant low or medium cloud was observed between 18 GMT and 06 GMT the following day in any instance.

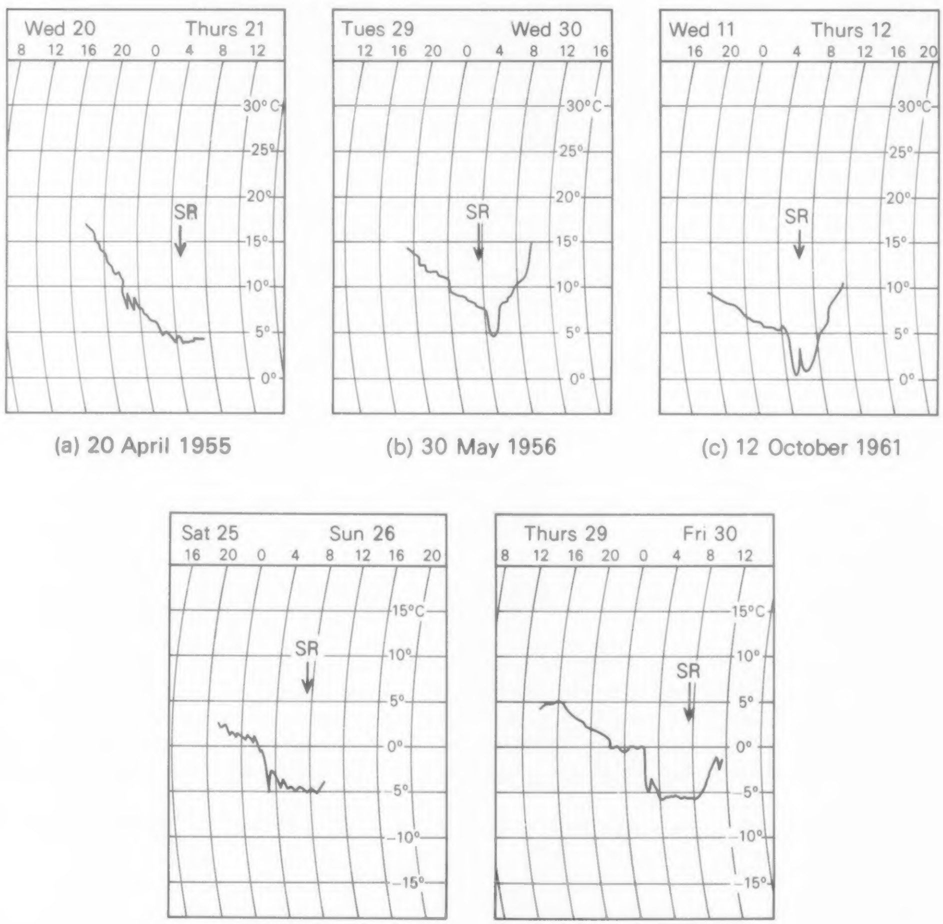
20 April 1955

At 18 GMT Lyneham was in a weak north-westerly geostrophic flow on the south-west flank of a shallow depression over the north Midlands. The flow subsequently veered to just east of north and strengthened slightly as the depression moved south-eastwards to be centred near London at midnight.

During the evening the temperature behaved much as would have been expected, falling steadily until just after 22 GMT when there was a sudden fall of over 3.5 °C (Fig. 4(a)).

Despite the north-westerly geostrophic flow the surface wind during the early part of the cooling period was very light and generally from the south or south-west but, coincidental with the temperature fall, it shifted to the north and increased to about 3 m s^{-1} (Table I(a)). Thereafter the wind remained in this quarter for the remainder of the night.

Visibility remained good during the whole period.



(a) 20 April 1955 (b) 30 May 1956 (c) 12 October 1961

(d) 26 November 1961 (e) 30 January 1981

Figure 4. Copies of Lyneham thermographs during five sudden and large drops in temperature (SR = sunrise).

Table I. *Lyneham observations during each of the five events (sky visible on each occasion and no significant cloud).*

(a) *20 April 1955*					
Time GMT	20	21	22	23	00
Wind (°/m s^{-1})	180/0.5	210/0.5	240/1.0	350/2.5	350/3.0
Temperature (°C)	13.5	12.6	11.9	8.6	7.8
Visibility (km)	24	16	16	16	13
(b) *30 May 1956*					
Time GMT	02	03	04	05	06
Wind (°/m s^{-1})	220/4.5	220/4.0	360/1.5	Calm	Calm
Temperature (°C)	9.1	8.4	6.5	5.3	8.9
Visibility (m)	1300	11000	100	700	200
(c) *12 October 1961*					
Time GMT	02	03	04	05	06
Wind (°/m s^{-1})	200/1.0	230/1.0	230/1.0	Calm	Calm
Temperature (°C)	7.2	7.0	6.9	2.4	3.0
Visibility (m)	4000	4000	4000	300	1700
(d) *26 November 1961*					
Time GMT	01	02	03	04	05
Wind (°/m s^{-1})	200/1.0	200/1.0	210/1.0	050/1.0	340/1.0
Temperature (°C)	2.3	1.7	−4.2	−2.9	−3.8
Visibility (m)	700	200	100	100	80
(e) *30 January 1981*					
Time GMT	00	01	02	03	04
Wind (°/m s^{-1})	080/1.0	130/1.0	140/1.0	150/1.0	340/1.0
Temperature (°C)	0.3	1.2	0.9	−4.2	−3.8
Visibility (m)	200	1000	5000	600	200

30 May 1956

The weather over southern England was dominated during the early hours of 30 May by an anticyclone, which at 06 GMT was centred just south-west of Lyneham.

Although the wind had been north-easterly 2.5 m s^{-1} earlier in the night, between 01 and 03 GMT a 3–4 m s^{-1} south-westerly developed which, considering the almost total lack of pressure gradient, is more than a little surprising.

Subsequent to the 03 GMT observation fog was observed 'forming quickly to the north' and by 04 GMT visibility had decreased to 100 m, although the sky was still clearly visible, and the wind had become northerly 1.5 m s^{-1} (Table I(b)). At the same time the thermograph recorded a rapid fall in temperature of over 3.5 °C (Fig. 4(b)).

12 October 1961

At 06 GMT an anticyclone was centred just north-east of Lyneham, having moved north during the previous six hours as an intensifying feature.

On this occasion mist developed on the airfield during the previous evening and shallow fog was observed to the south-east at 02 GMT. Although there was little change in the temperature during the next two hours (Table I(c)) there was a sudden fall of over 4.5 °C shortly after 04 GMT (Fig. 4(c)) and visibility fell from 4000 m to 300 m. Before this the wind had been south-westerly 1 m s^{-1} but subsequently fell calm.

An amplifying note in the *Daily Register* at 07 GMT indicates that the fog was shallow but more than 2 m deep and, although visibility improved to 11 km during the hour, a further note records fog persisting in the valley to the south-east.

26 November 1961

The main synoptic feature during this event was a weak ridge of high pressure extending east–west across southern England at 00 GMT. Individual high cells could be identified within this ridge, one being just north of Lyneham.

Fog developed on the airfield when the temperature fell to 2°C shortly before the 23 GMT observation on the 25th. Subsequently there were only minor temperature fluctuations until just before 03 GMT when the temperature plummeted to −4.2°C (Fig. 4(d)).

Before this the wind was a steady 200°/1 m s^{-1} but by 04 GMT it had become 050°, subsequently backing to 340° by 05 GMT (Table I(d)).

30 January 1981

The previous descriptions are necessarily brief owing to the lack of complementary data and suitable instrumentation. The following account of the event on 30 January 1981 contains references to observations elsewhere in the locality and it must be noted that some of the temperatures were recorded with non-standard instruments in overexposed locations. Special reference is made to data from Corsham (93 m above m.s.l.) in the Avon valley, Devizes (137 m above m.s.l.) at the western end of the Vale of Pewsey (but near the foot of steep slopes similar to Lyneham Banks) and Yatesbury (168 m above m.s.l.) on the Marlborough Downs.

Temperatures at Corsham and Yatesbury are recorded in Stevenson screens, but the Devizes thermometer, a Six's, is *underexposed*, being close to the junction of a hedge and north-east side of a house, and covered with a brown wicker waste-paper basket.

The southerly airstream which existed over southern counties at 03 GMT (Fig. 5) had developed some time previously and was maintained by a ridge of high pressure extending north-west from an anticyclone over central Europe. Upper-wind soundings made at Larkhill (33 km south of Lyneham) before and after the event, showed 0.5 – 2.5 m s^{-1} south-easterlies at the surface veering with height to become 2.5 – 5.0 m s^{-1} south-south-westerlies at 900 m above m.s.l.

Extensive low cloud and poor visibility affected much of England on the morning of the 29th but conditions improved considerably during the afternoon as cloudless air moved north from France. This clearance reached Lyneham soon after 15 GMT and before long the temperature began to fall steadily. At 22 GMT a sudden fall of 1 °C (to 1 °C) coincided with a brief shift of wind from 120° to 010° and fog was observed on the airfield. Following a slow veer of wind to 130° the fog dispersed at 0030 GMT as the temperature rose to 1.2°C. At 0218 GMT the wind unexpectedly backed to 330–360°, contragradient, (Fig. 6) and as the temperature plummeted to −4° C (Fig. 4(e)) the visibility fell to 100 m. Thereafter the temperature remained below this value until after dawn, apart from a brief recovery at 03 GMT.

Comment has already been made on the anomalous strength of the wind before the event on 30 May 1956 and, curiously enough, although it was not shown by the hourly observations, the wind also increased on this occasion, to 2.5 m s^{-1} for 20 to 25 minutes at 01 GMT (Fig. 6).

Despite visibility falling at times to 100 m the vertical depth of the fog was never very great, the fog top probably being 15–20 m above the airfield (or 105 m above the valley floor). This is consistent with the 06 GMT Larkhill ascent (Fig. 7) which shows high humidity being confined to a shallow surface layer.

Dense fog formed at Corsham between 2100 and 2130 GMT at a temperature of 0.6 °C (Lyneham temperature at this time was 2.2 °C), but despite the fog the temperature continued to fall steadily before reaching a minimum of −2.7 °C at 09 GMT (Fig. 8), over six hours after the temperature fell to −4 °C at Lyneham. Minimum temperatures recorded elsewhere in the Avon valley were generally between −2 °C

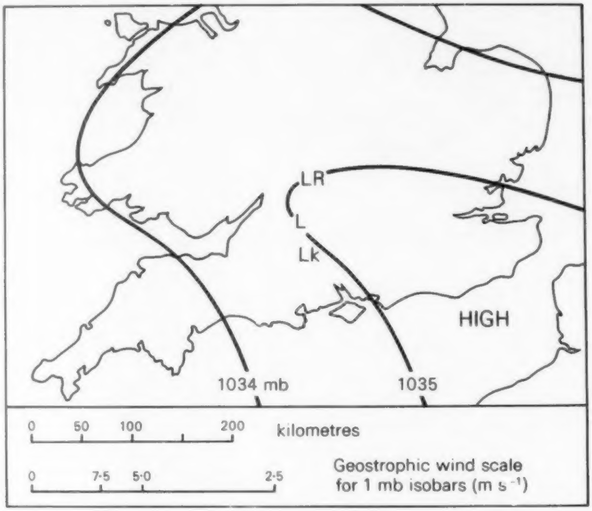


Figure 5. Synoptic situation at 03 GMT on 30 January 1981. (L = Lyneham, Lk = Larkhill and LR = Little Rissington.)

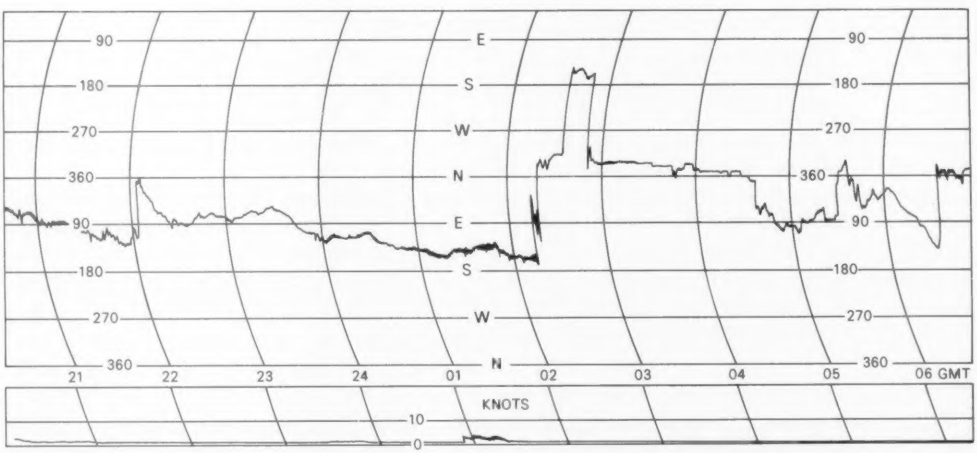


Figure 6. Copy of Lyneham anemogram for 29–30 January 1981.

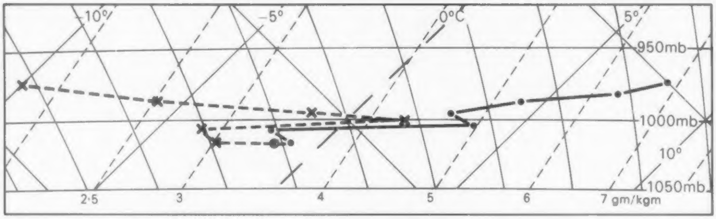


Figure 7. Larkhill radiosonde data for 06 GMT on 30 January 1981.

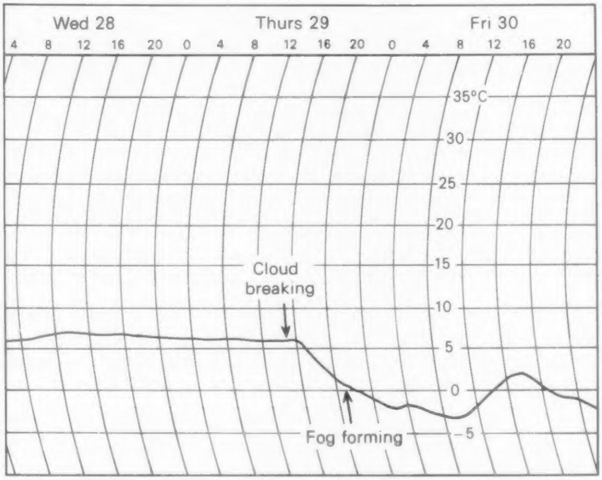


Figure 8. Copy of Corsham temperature trace for 29–30 January 1981.

and −3 °C (Fig. 9), but the −6 °C at Devizes and the −4 °C of the fog which engulfed Lyneham are indicative of pockets of colder air at the foot of steep slopes.

It has been estimated from average clear-sky cooling curves for January-February (unpublished data held at Lyneham) that the minimum temperature at Lyneham would have been about −0.5 °C if the airfield had not been affected by fog. This is considerably higher than the minimum of −3.7 °C recorded at Yatesbury despite the site being 12 m higher than Lyneham, but the discrepancy can be readily accounted for by the different drainage characteristics of the two sites, since Yatesbury lies in a depression whereas Lyneham is on a dome-shaped outcrop.

Discussion

With the exception of 20 April 1955 each of the events occurred on anticyclonic radiation nights and (with the further exception of 26 November 1961) coincided with fog spilling on to the airfield from the adjacent Avon valley, the fog being restricted to a shallow depth by a marked, but shallow, inversion.

Considered in isolation it would be difficult to explain the temperature fall on 26 November 1961,

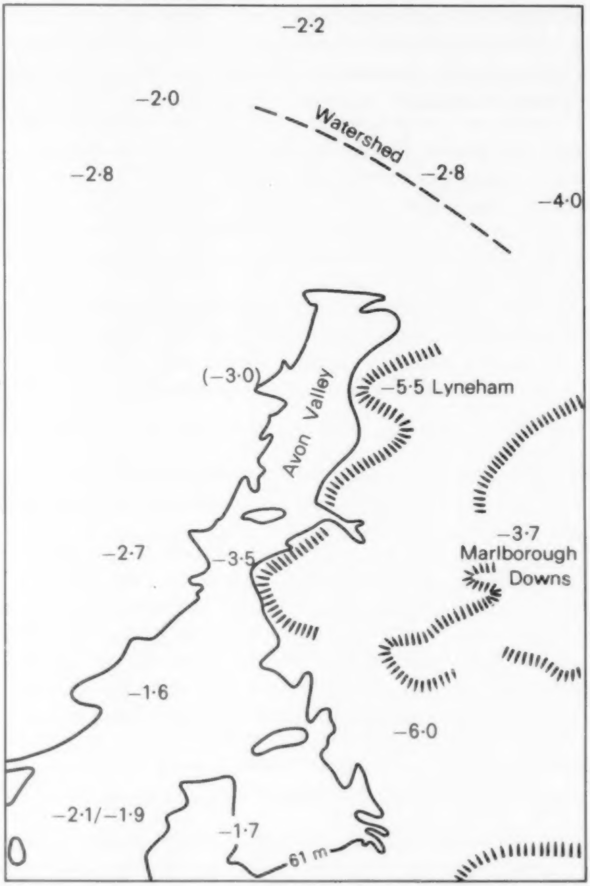


Figure 9. Minimum temperatures (°C) recorded in the vicinity of Lyneham on the night of 29–30 January 1981. ((−3.0) is an actual temperature read at 0730 GMT.)

since fog had developed *in situ* on the airfield some four hours before the event. However, in view of the remarkable similarities between this and the event of 30 January 1981, it would seem that this event was brought about in the same manner as were the other three, the difference being that the arrival of the valley fog (and hence the cold air) was masked by the existing fog.

In both cases the wind had a light southerly component before the temperature fall and a light northerly component after it; the events occurred at almost identical times; the temperature falls exceeded 5 °C and were immediately followed by temporary recoveries (Figs 4(d) and 4(e)) and, finally, the lowest temperatures recorded during the events were between −4 °C and −4.5 °C.

When fog forms in the Avon valley on radiation nights Lyneham often remains fog-free until after

dawn when conditions deteriorate as fog is lifted out of the valley by insolation or wind. Occasionally, however, subsequent radiative cooling from the fog top results in the fog deepening sufficiently to spill on to the airfield before dawn, with the associated temperature changes reflecting the different rates of cooling between the hill and valley locations. These temperature changes are usually relatively small, but larger ones do occur, and the very large falls described here are notable examples of the phenomenon. None the less, although such sudden changes in temperature are rare they are by no means unique to Lyneham, similar events having been noted at Little Rissington (229 m above m.s.l. and 100 m above adjacent valleys) by Konieczny (1957).

The events of 26 November 1961 and 30 January 1981 are especially noteworthy in that the cold valley air somehow acquired sufficient southward momentum, as it spilled on to the airfield, to overcome the existing gradient-induced surface flow.

The event of 20 April 1955 differs from the others in that it occurred when there was no fog. In this case radiation conditions during the early evening were ideal for a lake of cold air to collect in Dauntsey Vale. In the absence of any fog this would have deepened only slowly and would not have affected the airfield had it not been advected southwards by the strengthening northerly wind.

Conclusion

These sudden temperature falls occurred on radiation nights and were caused either by fog-free cold air being advected from the adjacent low ground by an increase in wind, or by fog developing in the same area and deepening sufficiently to suddenly engulf the airfield.

In both situations the suddenness of the temperature change is probably due to the close proximity of the airfield to the source of cold air (the instrument enclosure is 1000 m from the scarp at the airfield boundary), and the lack of mixing as the cold air crossed the intervening ground.

Although Lyneham forecasters have long been aware that nocturnal temperatures in the Avon valley are significantly lower than those experienced on the airfield, no attempt has ever been made to quantify the differences. Remembering therefore that this analysis relates essentially to foggy situations, it would not be unrealistic to expect minimum temperatures in the Avon valley on radiation nights to be generally 3°C or 4°C, or locally as much as 6°C, cooler than at Lyneham. (Harrison (1967) has observed comparable temperature variations over similar terrain in Kent.) Moreover, the greater part of this temperature differential develops during the early part of the cooling period and can occur at any season.

The events described are particularly instructive examples of the inadvisability of assuming a single station's observations to be representative of an area—especially on radiation nights.

Acknowledgements

A great many people, both within the Meteorological Office and elsewhere, have contributed to this discussion. In particular I would acknowledge the assistance given by Mr. R. Gosnell for his search of Lyneham's records to identify previous instances of the phenomenon, Mr. Mortimore of Corsham, Mr. Colman of Devizes and Mr. Partridge of Yatesbury.

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Konieczny, J. 1957 Abnormal temperature and visibility variations at Little Rissington on December 19–20, 1956. *Meteorol Mag*, **86**, 376–378.

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The influence of snow, fog and heavy rain on the demand for road transport information at Glasgow Weather Centre

By K. Smith

(Department of Geography, University of Strathclyde)

Summary

The number of enquiries received by Glasgow Weather Centre depends both on the current weather and the needs of the enquirer; average hourly totals are shown to vary systematically through the day and daily totals to vary through the week with a peak on Fridays. Rapid increases in the enquiry rate are produced by snow, fog and heavy rain in decreasing order of importance; snow can cause a rise in enquiry rate of over 600% in a three-hour period.

Introduction

Certain weather hazards disrupt road transport and lower road safety standards. In particular, snow and ice cause slippery roads whilst fog reduces visibility. Such hazards can occur in combination and affect both road surface conditions and visibility, as in the case of freezing fog or falling precipitation.

Since road transport appears to be affected immediately by bad weather, it is reasonable to suppose that this weather sensitivity will be reflected in the demand for meteorological information by road users. It is equally reasonable to suppose that routine weather forecasts will not always be able to meet the immediate need for the local information and the consumer will turn to the nearest Weather Centre for advice, as shown by Smith (1981). However, the previous study failed to indicate the high day-to-day variability of road transport enquiries and their dependence on adverse driving conditions. These factors are important because the concentration of such enquiries on days of poor winter weather is mainly responsible for the peak demands imposed on the Weather Centres. Therefore, the aim of the present paper is to examine how the demand for meteorological information by road users is influenced by snow, fog and heavy rainfall.

Road transport enquiries at Glasgow Weather Centre

Glasgow is the third busiest Weather Centre in Britain and, over the past two decades, the annual total of 'spontaneous' road transport enquiries (i.e. enquiries that have not been pre-arranged) has risen from less than 1500 to a maximum of nearly 25000 in 1978. These figures represent about 20% of total Weather Centre enquiries. Well over 90% of all these spontaneous enquiries are made by telephone and normally two forecasters answer such queries during the approximate hours of daylight between 06 and 18 GMT. The forecasters log each enquiry according to a standard system, including road transport, to produce hourly categorized totals for the 12 'daylight' hours plus a grand total for the full 24-hour day. Four public telephone lines were employed until a decision to limit the availability of this service reduced the number to two on 13 April 1979 with a further reduction to one line only on 9 February 1981. Thus, public access to this type of information has been limited, especially during periods of peak demand, and the annual enquiry total has dropped each year since 1978.

The concentration of demand by road users during spells of bad weather is very evident. Seasonally, well over 95% of road transport enquiries occur in the seven months from October to April inclusive and the only two months which have ever generated an aggregate of more than 15000 enquiries were the particularly wintry months of January 1978 and January 1979 when transport enquiries were dominant.

The highest ever individual daily total for road transport enquiries was 980 recorded on 29 December 1978, when snow fell throughout the day giving an accumulation of 6 cm in the city by 18 GMT. Peak daily transport enquiries fell to 578 in the 1979–80 winter and to 276 in 1980–81.

In view of the marked seasonal demand for weather information from road users, the remainder of this paper analyses daily and hourly road transport enquiries during the October–April winters for the years 1978–79, 1979–80 and 1980–81. These data reveal that, in addition to the seasonal pattern, community factors operate to produce a cycle of demand on smaller time-scales. Fig. 1 illustrates the mean daily totals of road transport enquiries received through the week during the study period. It is evident that the major demand occurs on Fridays, when the daily incidence is almost double the demand at the beginning of the week. This pattern implies that the information is used largely in the planning of, and participation in, leisure activities. The change in demand through the day is even more regular, although the individual hourly totals vary considerably according to month (Table I). In all cases demand rises quickly in the early morning to reach a peak between 09–10 GMT as consumers assess the prospects for travel during the day. Thereafter, there is a gradual decline in enquiries, only temporarily arrested by a small secondary peak in mid-afternoon (15–16 GMT) before a rapid recession in late afternoon. A comparison of the 12-hour totals with the 24-hour totals shows that rather more than 80% of all road transport enquiries are confined to the 'daylight' half of the day. Table I also details the marked mid-winter increase in the enquiry rate at all hours with the peak morning period in January generating more than 10 road transport enquiries per hour during an average day. On a few occasions during snowfall, and with all four telephone lines open, it has been possible for the Weather Centre to service 120 road transport enquiries per hour at the morning peak period.

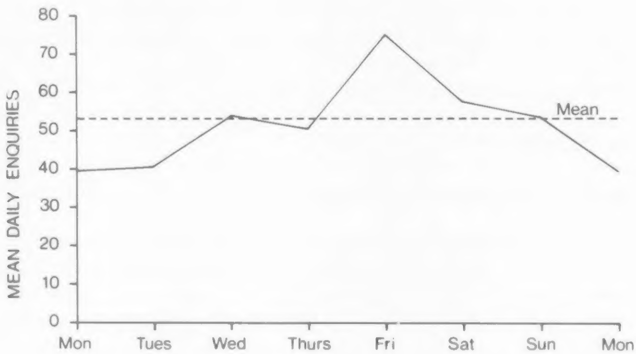

Figure 1. The weekly cycle of mean daily road transport enquiries at Glasgow Weather Centre.

It is apparent that these road transport enquiries are influenced not only by bad weather but also by consumer requirements which must be considered in any analysis. Similarly, an acceptable methodology must take account of the reduced availability of public telephone access to the Weather Centre over the period concerned.

Table I. *Mean number of hourly and daily road transport enquiries during the* 1978–79 *to* 1980–81 *winter periods at Glasgow Weather Centre.*

	Average number of enquiries per hour												12-hour total	24-hour total	Percentage of daily enquiries 06–18 GMT
Month	6–7	7–8	8–9	9–10	10–11	11–12	12–13	13–14	14–15	15–16	16–17	17–18			
Oct.	0.13	0.26	0.55	0.94	0.77	0.42	0.39	0.35	0.19	0.26	0.16	0.23	4.65	5.80	80
Nov.	0.83	1.33	2.10	2.83	2.80	2.67	2.30	2.10	2.10	1.97	1.93	1.70	24.66	29.78	83
Dec.	1.29	2.10	5.13	7.06	5.77	5.03	4.58	4.45	4.68	5.19	4.55	4.29	54.12	69.65	78
Jan.	1.74	3.13	6.84	13.90	13.35	12.48	9.74	9.81	9.26	9.58	7.81	6.23	103.87	119.63	87
Feb.	1.21	1.64	4.00	8.89	7.71	6.36	5.61	4.79	4.11	4.32	3.93	3.07	55.64	64.15	87
Mar.	1.58	2.97	5.23	9.26	8.06	7.16	5.71	5.00	5.13	5.32	3.39	2.61	61.42	70.94	87
Apr.	0.33	0.40	0.83	1.30	1.13	0.83	0.63	0.53	0.47	0.30	0.33	0.20	7.28	8.42	86
Mean	1.02	1.69	3.53	6.31	5.66	4.99	4.14	3.86	3.71	3.85	3.16	2.62	44.53	52.62	84

Methodology and interpretation of results

Hourly totals of road transport enquiries for the three winters were abstracted from the Weather Centre log sheets and combined to give 12-hour and 24-hour daily totals for each seven-month season. Meteorological data were obtained from Glasgow (Abbotsinch) airport which lies some 10 km to the west of the city centre. As such, the airport is well within the region served by the Weather Centre and is reasonably representative of the outer suburban ring which supplies many commuters to the city. From the available observations, the following periods and severities of weather hazards were defined:

Snowfall

(1) 3 hours with $\geqslant$ 0.5 cm fall (06–18 GMT)
(2) 12 hours with $\geqslant$ 0.5 cm fall (06–18 GMT)
(3) Days with sleet or snow falling (00–24 GMT).

Fog

(1) Dense—hours with visibility $<$ 100 m (06–18 GMT)
(2) Thick—hours with visibility 100–200 m (06–18 GMT)
(3) Days with visibility $<$ 200 m (00–24 GMT).

Heavy rainfall

(1) Hours with $\geqslant$ 4 mm fall (06–18 GMT)
(2) Days with $\geqslant$ 20 mm fall (00–24 GMT).

The analytical method adopted was the 'matched-pair' approach used by Bertness (1980). This method firstly involved preparing a list of all the periods which met a criterion for a weather hazard as defined above. Then the hour, 3-hour period or day exactly one week later than each defined hazard period was checked to see if it conformed to the same, or any of the other, hazard criteria. If it did not, it was selected for the sample. If it did so (i.e. if the attempted matched period reached any of the hazard thresholds indicated) or if it fell on a holiday period, it was rejected. In this case, the period exactly one week before the hazard period was selected, provided that it was a non-hazard period and had not

previously been matched to any other hazard day. If neither of the potential non-hazard periods was acceptable, both they and the initial hazard period were withdrawn from the sample. This procedure was undertaken sequentially for snow, fog and heavy rain. Using the paired lists, the numbers of road transport enquiries were then compared, using the *t*-test, to determine the effect of the particular weather hazard.

The advantages of the matched-pair approach are that, despite the inevitable exclusion of many periods through the cross-checking procedure, it can produce statistically significant results with relatively small samples. Equally important is the fact that the study area serves as its own control for factors such as road conditions or traffic volumes which may affect a road user's perception of transport problems. By matching periods exactly seven days apart, the method eliminates any complications arising from regular hourly or day-of-the-week variations or any problems caused by the planned reduction in telephone access to the Weather Centre.

On the other hand, certain assumptions underlie the methodology:

(1) *Temporal and spatial sampling.* It is assumed that transport enquiries represent a direct reaction to the onset of bad weather, i.e. that no consumers are wanting long-term forecast advice or any road transport information unrelated to the prevailing weather conditions in the local area. There is also an assumption that meteorological observations at one site are representative of the weather over the entire area.

(2) *Identification of weather hazards.* The threshold values selected are entirely arbitrary, although it is believed that they contribute substantially to reduced visibility and low road friction. It has not been possible to exclude adverse weather completely from the 'non-hazard' periods which may have low temperatures or high winds, for example. Similarly, the effect of multiple hazards cannot be explored even though it is likely that, for example, there will be more enquiries during periods of freezing fog than will occur with equivalent visibilities at higher temperatures.

(3) *Accuracy of enquiry totals.* Complete accuracy cannot be expected from the enquiry data, especially during periods of peak demand when the forecasters may be too busy to log every call and potential consumers may find all the telephone lines engaged. These people will either do without the weather information they were seeking or turn to other sources, e.g. the Automatic Telephone Weather Service. Such circumstances will lead to an underestimation of the effects of adverse weather on demand. It is also possible that, largely as a result of imprecise information provided by the consumer, there may be errors in the classification of road transport enquiries relative to other calls, although it is believed that individual categories are correct to within $\pm$ 5% (Allardice, private communication).

Results

The detailed results are presented in Table II. It can be seen that all weather hazard periods produced at least a two-fold increase in enquiries. Since measured snowfall data were not available on an hourly basis, it is impossible to compare the three selected hazards over periods of less than 24 hours. However, if the enquiry totals associated with measurable snowfall can be assumed to distribute evenly over the constituent individual hourly periods, then it would appear that such heavy snow produces an average of at least 25 road transport enquiries per hour compared to 12 for dense fog and 3 for intense rain. It should be stressed that these enquiry rates refer to the hours between 06 and 18 GMT when most road use takes place. The same pattern is evident over the full day. Taking the mean of three separate winter totals for snowfall days, it may be deduced that a day with either sleet or snow falling, however slight the

Table II. *Number of road transport enquiries during selected weather hazard and matched non-hazard winter periods at Glasgow Weather Centre. (All periods less than 24 hours in length lie between* 06 *and* 18 *GMT.)*

Weather hazard period	Mean number of enquiries during hazard period	Mean number of enquiries during matched non-hazard period	Ratio	*N* (number of pairs)	Significance*
Snowfall					
⩾0.5 cm per 3 h totals	77.32	12.16	6.36	19	HS
⩾0.5 cm per 12 h totals	335.50	59.83	5.61	12	HS
Days with sleet/snow falling (24 h totals)					
winter 1978–79	210.61	57.51	3.66	41	HS
winter 1979–80	104.50	22.58	4.63	26	DS
winter 1980–81	90.13	19.76	4.56	38	HS
Fog					
Visibility < 100 m per 1 h totals	12.52	4.07	3.08	27	DS
Visibility 100–200 m per 1 h totals	5.55	2.14	2.59	22	NS
Days with visibility < 200 m (24 h totals)	78.93	32.93	2.40	14	PS
Heavy Rainfall					
⩾4 mm per 1 h totals	3.00	0.50	6.00	10	NS
Days with ⩾20 mm (24 h totals)	29.55	13.00	2.27	11	NS

*NS (not significant) indicates significance at 0.10 level
PS (probably significant) indicates significance at 0.05 level
DS (definitely significant) indicates significance at 0.01 level
HS (highly significant) indicates significance at 0.001 level

amount and irrespective of when it falls, produces some 130 transport enquiries compared to approximately 80 for days with thick fog and 30 for days with heavy rainfall. The marked decline in mean snowfall day enquiries from over 200 in 1978–79 to less than 90 in 1980–81 may be largely explained by the reduced telephone access to the Weather Centre.

This overall rank order of hazard influence is confirmed by the statistical testing. All the snowfall results emerge as statistically significant, mostly at the highest level, depite the expectation that the 24-hour results might be less significant than the 3-hour results if the enquiry reaction is assumed to be immediate. The fog hazard seems to operate at a rather lower level of statistical significance, although there is a clear difference between the definitely significant hourly result for dense fog (visibility < 100 m) compared with the unsignificant result for thick fog (visibility 100–200 m). Apart from the fact that driving conditions improve considerably with horizontal visibilities beyond 100 m to prompt fewer enquiries, it is likely that some of the fog observations will be confined to the vicinity of the airport which lies close to the valley of the Black Cart Water and its confluence with the river Clyde. There is no evidence that rain falling at the intensities defined in this paper has any statistically significant effect on road transport enquiries. This result is difficult to account for with certainty. It is possible that the thresholds adopted are too low for rainfall to present a hazard to road users but it is also possible that the relatively high frequency of rainfall in the Glasgow area may have led to some behavioural adaptations by local drivers who have learned to live with the hazard without needing to seek weather advice.

Conclusion

Any weather sensitivity shown by road transport enquiries does not necessarily imply an equal sensitivity of road transport use since no direct knowledge is available concerning the weather information consumer, the reason for his enquiry and the use, if any, which is subsequently made of the information. Despite this limitation, two major conclusions emerge. Firstly, it has been demonstrated that the demand for weather-related road transport information is influenced on a regular basis by community factors which control the weekly and diurnal rhythm of enquiries. Over a longer time-scale, the effect of decisions to reduce the availability of this service to the public can also be seen. Secondly, and more important from the viewpoint of this paper, distinctive concentrations of enquiries have been found to occur, on timescales from the season down to hourly intervals, in association with atmospheric conditions. Bad weather is highly effective in creating short-term demand peaks. Snowfall has the greatest effect and is capable of increasing demand around six-fold during the working day to produce an enquiry rate well in excess of 100 per hour. This effect appears to be approximately double that associated with fog. There is some evidence for a rise in enquiries linked to heavy rainfall but no statistical significance can be attached to the results.

Acknowledgement

The author wishes to thank Mr J. G. Allardice, Senior Meteorological Officer at Glasgow Weather Centre, for supplying the enquiry data and most of the meteorological information used in this paper. Mr Allardice also made valuable suggestions concerning the interpretation of these data, although the responsibility for the opinions and conclusions expressed remains with the author.

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Retirement of Mr D. R. Grant

Mr D. R. Grant, B.Sc., Assistant Director (Observational Requirements and Practices) retired from the Meteorological Office on 20 September 1982 after a career of 34 years covering a wide range of meteorological activities in both the Research and Services sides of the Office.

Donald Grant was born in 1922 in Newport, Fife, and was educated at the Royal High School, Edinburgh and Edinburgh University. He joined the Office as a Scientific Officer in August 1948 and, following the usual Scientific Officer Course and short detachment (to Pitreavie) for forecasting experience, he spent the next three years at the Meteorological Research Flight developing an ultra-rapid response thermometer (URT) for use on aircraft in the study of the small scale variability of temperature in the atmosphere.

From 1951 to 1959 he continued his interest in instrumentation in the Upper Air Instruments Development Branch (then called M.O. 17) and in 1952 he was promoted to Senior Scientific Officer. Although his report on the ill-fated radar sonde project resulted in its abandonment, the work put into the meteorological sensors was not wasted, and with some modifications these sensors are still in use in the Mk 3 Radiosonde today.

After a short spell as a forecaster at Heathrow from 1959–61, Mr Grant returned to the Meteorological Research Flight in 1961 on promotion to Principal Scientific Officer. There he took up his interest in convection again using the URT and radio refractometer installed on the MRF aircraft, and produced a number of papers on the topic. He was also involved at that time in looking at some of the problems involved in measuring air temperature from supersonic aircraft.

Five years later, in 1966, he was posted to the Middle East as Chief Meteorological Officer in Aden. One of his first major tasks there was to organize the move of meteorological services to Bahrain following the evacuation of Aden by British forces. This was only a short spell abroad, however, and in 1967 he was back in the United Kingdom as Principal Meteorological Officer of the Meteorological Research Unit, Cambridge. During his stay in Cambridge he produced further research papers on a study of methods of measuring evaporation from crops (such as barley) in a joint project with the Cambridge University Departments of Agriculture and Botany and the Plant Breeding Institute.

After five years at Cambridge, he moved back to Scotland as Superintendent of the Office at Edinburgh, a job which allowed him to make full use of his wide background knowledge. There he was very successful in opening up new contacts with the Scottish meteorological community and broadening the scope of the work there.

It was no surprise when in 1975 he was promoted again to become Assistant Director in charge of the Special Investigations Branch of the Office, where he was able to make full use of his varied background. His thoroughness and attention to detail proved of great use in this post, and have continued to stand him in good stead in his final post (since 1977) as Assistant Director of the Branch responsible for Observational Requirements and Practices. There, as Chairman of the Working Group on the UK Observational Network, he has had a considerable influence on the development of the Meteorological Office's new observing system. He was also Chairman of the Working Group on the Introduction of the New Common Surface Codes, and it was largely due to him that this significant change was brought about so smoothly on 1 January 1982.

Mr Grant has been a Fellow of the Royal Meteorological Society since 1948; he has published papers in the *Quarterly Journal of the Royal Meteorological Society*, the *Journal of Scientific Instruments*, the *Meteorological Magazine*, the *Journal of Agricultural Science*, *Agricultural Meteorology*, and the *Journal of Soil Science*. He has been active and well known in the international meteorological community, in particular during his five years as the United Kingdom representative on the WMO Commission for Basic Systems (CBS) Working Group on the Global Observing System. He has also been a United Kingdom delegate to meetings of the WMO Commission for Basic Systems and a number of WMO Study Groups.

Donald Grant married in April 1961 and has three children. In his retirement he will continue his close association with meteorology, since he will take up a new appointment as Executive Secretary of the Royal Meteorological Society. We therefore expect to continue to see quite a lot of both him and his wife Jill. We wish them a long and happy time in this new way of life, and hope that they will continue to enjoy good health and contentment.

D. N. Axford

Notes and news

Sir Napier Shaw and the Meteorological Office in 1900

Our September issue (Notes and news—25 years ago) contained a reference to the obituary of R. G. K. Lempfert—the first member of the Office to be appointed holding professional scientific qualifications – and quoted some comments by Sir Napier Shaw who was responsible for having the appointment made.

A letter written by Sir Napier on his retirement in 1920 and published in our issue for December of that year sheds interesting light on the difficulties he faced on taking charge of the Office in 1900. It is addressed to the Chairman of the Meteorological Committee, Major-General Sir Frederick Sykes, Controller-General of Civil Aviation:

10, Moreton Gardens,
Old Brompton Road, S.W.5,
16 November 1920.

DEAR GENERAL SYKES,

PLEASE convey to the Members of the Meteorological Committee my warm acknowledgment of their kindness in sending by you so cordial an appreciation of my services to the Meteorological Office.

I have indeed been fortunate. In the early days of my work as Secretary I was rather disconcerted by Sir Francis Galton. He had retired after giving a large part of his life to the control and also the practical management of the Office, and of the Kew Observatory at Richmond. He had been also largely responsible for advising the Government upon meteorological affairs from 1860 onwards. When I went to see him about some office business he inquired very dubiously whether I really thought that anything could be made of it, and gave me to understand that he had little or no hope.

The situation was indeed difficult because the acknowledged ground of appeal for public funds for the Office was not the collection and ordering of trustworthy facts about the weather of all parts of the world for economic and scientific purposes, as it should be, but simply and solely forecasting the weather of to-morrow. And making predictions for publication from the beginning, is, and always will be, rather abhorrent to the mind of a person of scientific habit like Galton's unless it can be conducted by a strict process of calculation like the predictions of the Nautical Almanack. The objection is fundamental.

Galton had been instrumental in developing at the Office from 1867 to 1876 the chief properties of the travelling cyclone and anticyclone, the latter of which he had named; and in 1878 it appeared as though the process of understanding the weather would be the simple continuity of what had been already achieved. His disappointment at finding that nothing further came out of the study of cyclones and anticyclones protracted over twenty years was perhaps a legitimate cause for his pessimism. It was, I think, shared in 1899 by a Committee of the Royal Society appointed to consider what the Office was doing.

I found that the comparative stagnation in which the science was thus bogged arose with the formation of meteorology as a new science, partly geographical and partly physical, with the weather map as its basis of experience as distinguished from the individual observation. It was thus distinguished from the older meteorology, which had been entirely physical. Curiously the stagnation was compatible with the direction of the Office by the strongest body of scientific men that has ever directed anything. But the Office itself was simply clerical in its training, and it had no experimental observatories of its own.

I managed gradually to introduce a staff with scientific training, partly paid and partly voluntary, to take charge of various activities. They could look at the work from an extraneous point of view, and later on, not without some tears, I unified the control of the observational establishments of the Office.

So it happened that when General Seely wanted meteorological assistance at the beginning of the R.F.C. we could indicate the lines on which it could be given; and when the war broke out we had the type of organisation already in operation which could be developed simply by multiplication to meet the requirements of the case.

I am satisfied that the stagnation which overcame Galton is no longer to be feared. We have begun to see the way through, and that not by any facilities of a new era, but simply by following out methods which Galton himself had thought of and even commenced but had no trained staff to carry out.

I certainly shall like to give reasons at greater length for not accepting Galton's pessimism as a guiding

principle in the administration of the Office, and I think I can do so by the development of the School of Meteorology to which you allude so kindly; and I can still look upon the development of the science as some contribution to public service.

That I shall still have to rely upon the support and assistance of the Meteorological Committee in making that endeavour successful is only a pleasure for me, as the relations between myself and the Committee have always been in the past.

It was my experience of the old Meteorological Council that the capacity of distinguished men of science for understanding a difficult situation was only equalled by their capacity for misunderstanding a simple one when they were so inclined. It has been my good fortune always to have difficult situations for the Committee to deal with, and they have always been at their best. I need hardly assure them of my grateful thanks.

Let me also thank you for your personal note. The essential difficulty of the organisation of the Office is the proper adjustment of the scientific staff in relation to administration. At the time of its development it was necessary for the administration to be largely in the personal charge of the Director. That arrangement was not, of course, intended to be permanent, but the war broke out while we were still unfledged. Consequently, in transferring to the Air Ministry I had not only to think of what had been, but also of what might have been and would have been in the natural course of events. The difficulty of working a scientific establishment as part of a public office is that the customary duty of a public office is to exercise control, whereas the primary duty of a scientific establishment is experimental initiative, which to any controlling authority must have something of rash speculation about it.

I sincerely trust that the framework of the organisation which the Committee of 1905–20 gave to the Office will be found serviceable to the Air Ministry, and through them to the many folk for whom meteorological work has an interest of one sort or another.

With best wishes for its continued success,

Believe me,

Yours sincerely,

(Signed) NAPIER SHAW.

Major-General Sir Frederick Sykes, G.B.E., K.C.B., Air Ministry.

Meteorological Magazine—increase in price

As from January 1983 the price of an issue of the *Meteorological Magazine* will be £2.00 and the annual subscription will be £26.50 including postage.

Review

Deposition of atmospheric pollutants. Proceedings of a Colloquium held at Oberursel/Taunus, West Germany, 9–11 November 1981, edited by H.-W. Georgii and J. Pankrath. 165 mm × 240 mm, pp. ix + 217, *illus.* D. Reidel Publishing Company, Dordrecht, Boston, London, 1982. Price Dfl. 85.00, US $37.00.

These proceedings contain the texts of 20 lectures in addition to the introduction by J. Pankrath. The great majority of these papers, like that of the participants, came from the Federal Republic of Germany, and are divided into three sections covering respectively dry deposition, wet deposition, and deposition on plants and vegetation. To quote Professor Georgii's words in the preface:

> The problem of 'acid precipitation' has been recognized with growing concern in many industrialized countries. The incorporation of pollutants into cloud and rain elements and their transfer to the ground by 'wet deposition' are dominant

mechanisms leading to a self-cleansing of the troposphere but, on the other hand, to hazards to the soil, vegetation and forests. The influence of orographic and meteorological parameters and of the regional distribution of precipitation on the deposition of pollutants are insufficiently known factors.

During previous years, several projects and analyses have been initiated to improve our knowledge on the dry and wet deposition of pollutants and on the mechanisms of transport of gaseous and particulate components from the atmosphere to the ground. Research activities have been supported in different fields and it appeared not only useful but necessary to bring the different research groups together to endorse the communication and co-operation between scientists in the related fields. A symposium was arranged in Oberursel/Taunus in November 1981 to discuss the results of the experimental and theoretical work in the field of deposition and to gain a better understanding of each other's methods, experience and observations.

The papers presented in this symposium will be necessary reading for all workers in this important field.

R. P. W. Lewis

Award

We note with pleasure that Mrs G. W. S. Simpson, of Eddleston Auxiliary Reporting Station, has been awarded the British Empire Medal in the Queen's Birthday Honours List.

Mrs Grace Simpson began reporting in 1944 together with her husband, who was the station-master at Eddleston in Peeblesshire until the line closed in 1962.

The observations were initially required in connection with BEA flights between Turnhouse and Northolt. Balloons were often used to measure the height of low cloud.

Throughout the 38 years observations have been sent hourly between 8 a.m. and 5 p.m. on weekdays and between 8 a.m. and 12 p.m. on Saturdays. Mrs Simpson has continued this program single-handed since the death of her husband in 1976.

Mr S. Morris Bower

It is with regret that the Office records the death on 3 August 1982 of Mr S. Morris Bower of Auxiliary Reporting Station, Huddersfield/Oakes.

Samuel Morris Bower of the Thunderstorm Census Organization had been an enthusiastic meteorologist all his life and had reported as an auxiliary observer for the Meteorological Office since July 1935.

He joined the staff of the Meteorological Office in 1939 and saw service at a number of war-time stations including Falmouth, Sheffield and Topcliffe. In 1944 he returned to Huddersfield/Oakes from where, with his wife, he continued a full program of co-operation with the Meteorological Office. Mrs Bower died on 20 December 1981.

The station at Huddersfield/Oakes continues to operate under the direction of Miss M. K. Redman.

Obituary

We regret to record the death on 24 March 1982 of Mr N. Annis, Senior Scientific Officer, who was stationed at Lossiemouth. Norman Annis joined the Office as a Scientific Assistant in 1947 and was promoted to the forecasting grade of Assistant Experimental Officer the following year. His career was spent in forecasting at various outstations including Prestwick, Abbotsinch, and Glasgow Weather Centre, and he also served for three and a half years at Brüggen; he was promoted to Senior Scientific Officer in 1979. Norman Annis was a quiet and unassuming man, considerate to his colleagues and well liked by all he came in contact with, including his 'customers' in the RAF.

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NOTICES

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